and character of growth induced. The percentage and acreage amounts of phosphoric acid also vary very strikingly; and so again it is with other mineral constituents, but in a less marked degree.

It will be seen that in the history of so many of what may be called natural rotations, we can hardy fail to learn much that is of interest, not only in reference to the growth of the mixed herbage of permanent grass land, but also something of the relative positions of the different plants that are grown separately, in alternation with one another, in the artificial rotations adopted on arable land.

The botanical results are, moreover, of much independent interest, both by the facts which they already contribute, and by the incentive and direction they may give to future research.

Lastly, the chemistry of the subject will be found to offer many points of interest, in regard to the variation in the percentage composition of the produce, according to the manure applied; to the description of plants developed, and to the character of their development; to the availableness of the constituents artificially supplied; and to the amount and limit of the natural resources of the soil, both actually and compared with the results obtained when individual species are grown in arable culture.

It will be readily understood that the record, and the discussion, of the agricultural, the botanical, and the chemical history of about 20 plots, in 20 different seasons, must involve much detail; and although it is obvious that facts special to any one of the three main divisions of the subject may require for their elucidation reference to those of one or both of the others, it is still believed that it will conduce to clearness, and reduce unavoidable repetition, to maintain the divisions proposed as far as possible.

On the present occasion, Part I only, entitled—"The Agricultural Results," is presented. In Part II, "The Botanical Results," which will next follow, Dr. M. T. Masters, F.R.S., is joint author.

XXIV. "On the Comparative Structure of the Cortex Cerebri." By Bevan Lewis, L.R.C.P. Lond., Assistant Medical Officer, West Riding Asylum, Wakefield. Communicated by Dr. Ferrier, F.R.S., Professor of Forensic Medicine, King's College, London. Received June 18, 1879.

(Abstract.)

The object held in view throughout this investigation has been that of instituting an inquiry into the minute structure of the cortex of the brain in a prominent member of the Artiodactyla, and to critically compare the results with those obtained from an examination

of corresponding structures in certain members of the Ruminantia, Carnivora, Quadrumana, and also in the human brain. For this purpose the cerebrum was examined in the pig, sheep, cat, ocelot, and Barbary ape. In all cases the hemispheres were sliced from end to end in the fresh state upon the freezing microtone, and the sections examined *seriatim*, both fresh and after preparation by a process already described.* The regions to which special observation has been directed, are those over which a five- and a six-laminated type of cortex prevails, and which, in the members of the Ungulata examined, include the upper arc of the great limbic lobe (*gyrus fornicatus*), the frontal lobe, and the great mass of convolutions entering into the formation of the parietal lobe.

In this brief abstract I propose merely to enumerate the general conclusions arrived at, and which may be stated as follows :—

1st. In the Ungulata, as in higher Mammals, the cortex of the brain exhibits an extensive six-laminated region and a less extensive area constituted of five layers of nerve cells. These layers in the six-laminated cortex consist, as in higher animals, of a peripheral cortical layer, a second layer of small pyramidal cells, a third layer of large pyramidal cells, a fourth of small pyramidal and angular elements, succeeded by the large cells of the ganglionic series, and lastly the layer of spindle cells. The divergencies observed in various groups of animals are not dependent upon the general conformation and constitution of these layers, so much as upon differences observed in the essential characters of their elements and their mode of distribution.

2nd. In the five-laminated type, the second band of small angular and pyramidal cells is absent and the ganglionic layer assumes characteristic features.

3rd. Transition realms occur betwixt both laminated types in which the special features characteristic of the ganglionic series are in direct proportion to the thinning out and disappearance of the second band of angular elements.

4th. The ganglionic series in these members of the Ungulata differs from that of higher Mammals in the conformation of its individual elements and their distribution.

As to Conformation. The cells are more elongated, pyramidal in contour, and never assume the same average dimensions as those of the cat, ocelot, and ape. The swollen plump cell of these animals is never seen in the pig and sheep.

As to Distribution. They are scattered over a comparatively far wider area of the cortex.

5th. The pyramidal form assumed by these cells is, from reasons stated in the original paper, significant of far less complex relation-

* "Brain," a Journal of Neurology. Part iii. 1878.

ships through their branches, the latter being far more numerous in the swollen irregular cells of higher Mammals.

6th. The pyramidal cells of this layer closely approach in their dimensions and contour the larger pyramidal cells of the third layer in man and the ape, and may be assumed to work upon the same physiological level.

7th. The ganglionic series in these members of the Ungulata, assumes the clustered arrangement which is seen most highly developed in the motor area of the brain of the higher Mammalia. These clusters, or nests of Betz, are in the pig and sheep more densely packed with cells than in higher animals, cover oblong or oval areas of some depth, and in the most highly developed region of this lamination are so closely approximated that they tend to become confluent and assume most distinctive features.

8th. The regions over which the five-laminated cortex, with its nested cells, spreads, are for the Ungulata the anterior half of the great limbic lobe (superior arc), the whole of the frontal lobe, and the lower parietal gyri.

9th. The chief point of interest as regards the five-laminated cortex, is the fact that the whole ganglionic series throughout this extensive area maintains a remarkable uniformity of the magnitude of its elements, and in the complexity of their relationships.

10th. This fact is highly significant, since, upon localising the corresponding stratum in the cat and the ocelot, we find its grand development limited to the immediate neighbourhood of the crucial sulcus. On the other hand, in the ape and in man we find over a wide area of the cortex the same type of formation, but, far from there being general uniformity in the size and complexity of its cells, there is exhibited here an exceedingly rich development of this layer in the paracentral lobule of Betz, and the centre for the movements of the hand and arm, whilst other portions of the motor area are less conspicuously developed the more distant they are from these areas.

11th. These anatomical facts enable us to conclude:—

(*a.*) That in the Carnivora the motor centres are concentrated, so to speak, upon the limited area occupied by the limbic and parietal boundaries of the crucial sulcus.

(*b.*) That in the Quadrumana and Man they are more widely scattered and betray great divergence in developmental complexity at different sites.

(*c.*) That in the Ungulata they are still more widely scattered, but exhibit at all points a most noteworthy uniformity in their structural details and groupings, assuming, at the same time, a great resemblance to the elements of the third layer of the cortex in the higher orders of Mammalia.

12th. It is, therefore, inferred, that dissociation of centres plays an

important part in the explication of fundamental divergencies in the *rôle* of cerebral activity—thus, close concentrated association of centres is maintained in those animals where the associated movements of vast musculatures are required to act in concert for sudden and supreme efforts in the struggle for existence—hence the peculiar structure of the motor area in the cat and ocelot.

The dissociation observed in man and the ape appears to point to the comparative independence of special musculatures, to the possibility of their higher education, and (in the great disproportionate complexity of certain areas) to the pre-eminently high and complex relationships of these special centres and the musculatures which they represent.

The widespread dissociation of centres observed in the species of Ungulata examined, points, on the other hand, to a comparative simplicity in their resultant activities—there being in these animals no special demand for the collective and complex associations in action of widely separated musculatures.

13th. The results of the investigation lend still stronger confirmation to the belief that these anatomical units of the ganglionic layer are especially concerned in the production of those complex movements, which Ferrier has shown to be the special functional endowment of the motor area; and it is highly probable that a study of the dimensions, distribution, and relationships of these cells in the lower animals will serve to elucidate, in some degree, the diversified phenomena resulting from the excitation of this important area of the cerebral cortex.

NOTE.—In a recent contribution ("Psychiatrisches Centralblatt," Nr. 6), Meynert, referring to the discovery by Betz of the pyramidal cells in the motor area, attributes to it no importance. He states that the size of these cells depends simply upon the distance pursued by their processes towards the outer zone of the cortex. I need scarcely point out the self-evident fallacies involved in this line of argument. Suffice it to say, that such a rule cannot be one of universal applicability, since, although the size of these cells as a general fact increases with their depth, yet, from the second down to the fourth layer, we find numerous pyramidal cells no larger than those of the second layer. Again, over many regions of the cortex, the cells of the third layer are often larger than those of the fourth. In these cases, therefore, Meynert's assumption is untenable. Further, these cells are often larger at the sides of a gyrus and the bottom of a sulcus than beneath the summit of the convolution, *i.e.*, at a shallower portion of the cortex than at a deeper site. As this theory of Meynert does not explain the very specialized form, relationships, or arrangement of these elements, nor provide for the constant and extensive exceptions to be taken to his rule, the above considerations, together with others which must occur to a candid and careful inquirer, will prove wholly subversive of such a doctrine.